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Breastfeeding and early childhood caries: a critical review

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Abstract

Objective: To find scientific evidences that can prove or refute the assumption that nocturnal and on demand breastfeeding are associated with caries in infants and preschool children.

Sources of data: MEDLINE, Lilacs, and SciELO articles were searched, as well as important internet sites, technical books and consensus publications of national and international organisms. The following keywords were used: "early childhood caries", "dental caries", "dental decay" and "breastfeeding". References cited in the articles selected were also included.

Summary of the findings: Studies associating caries with breastfeeding invariably observe factors associated with how this disease develops, letting aside those associated with breastfeeding. Many of these factors act as confusing variables because in the same way as they interfere in breastfeeding, they also influence the development of caries. Besides, current studies have already demonstrated the cariogenic potential of some types of aliments given to children against the non-cariogenic potential of the human milk.

Conclusions: There are not scientific evidences proving that the human milk can be associated with the development of caries. This is a complex relation to be established, as it is often blurred by too many variables.

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Dental caries is still the most common infectious disease among children. In the United States, its prevalence is estimated to be five times higher than that of asthma and seven times higher than that of allergic rhinitis.[1,2] It is a preventable disease and its prevention begins at the pediatrician's.[3] Although pediatricians are the ones in charge of promoting children's oral health, few scientific studies on this topic have been published in pediatric journals.[2,4]

Caries is an infectious disease that is induced by the diet and, despite its decline in all age groups on a worldwide basis, especially due to fluoridization, its prevalence remains stable in deciduous dentition[5-7] (group of twenty teeth that form between 12 and 18 weeks of intrauterine life and erupt, on average, between 7 and 30 months of life).[8-10] It is still a serious public health problem and its control should be a priority, since it may lead to malocclusion of permanent teeth, cause phonetic problems and lower self-esteem.[11,12] It also has been demonstrated that dental caries can gradually reduce children's weight gain, which may be reversed after complete oral rehabilitation.[13]

The prevalence of caries in the general population is not well-defined, due to different methodologies, which hamper the comparison of results.[11,14] In Brazil, the Oral Health Project -2003 showed that 27% of children aged between 18 and 36 months and nearly 60% of five-year-old children had at least one deciduous tooth that was decayed. On average, a Brazilian child has at least one decayed tooth up to the age of three years, and three decayed teeth at the age of five years. Large regional diversities are perceived at all ages, and the rate of

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healthy lower teeth is lower in the North and Northeast Brazilian regions compared with the South and Southeast regions.[15]

In dentistry, there is quasi-consensus that breastfeeding on demand, especially at night and if prolonged, produces caries.[10,11,16-18] Likewise, in pediatrics, there are publications that share the same opinion.[7,19] The American Academy of Pediatric Dentistry (AAPD) declared that breastfed and bottle-fed infants are at a potentially devastating risk for caries due to breastfeeding. This is related to prolonged and repetitive feeding without proper oral hygiene, and is also related to the fact that parents are encouraged to offer their infants beverages in drinking cups before their first year of life and to stop bottle-feeding them between 12 and 14 months of life.[20] Without an accurate definition, the terms "prolonged exposure" and "weaning" had different interpretations, which culminated in the recommendation, by dentists, of weaning and cessation of breastfeeding before the first year of life . By discouraging prolonged breastfeeding and breastfeeding on demand,[10,19,21] they overlook all the well-documented benefits of breastfeeding and also the World Health Organization (WHO) recommendation to maintain breastfeeding up to the second year of life or longer.[22] Similarly, the American Academy of Pediatrics considers that infants who are put to bed with the bottle or who breastfeed during the night are at great risk for dental caries.[2,23]

Therefore, the presumable cariogenicity of breastmilk is an issue of paramount importance because, along with its substitutes, it is the major nutritional source in the first years of life.[24,25] In the present article, the authors present a review of the literature on the topic, and analyze several epidemiological studies that investigated a possible relationship between breastfeeding and caries.

Definitions

The expression early childhood caries (ECC) is currently used to replace the terms baby-bottle tooth decay and nursing caries.[7,26,27] The literature does not provide a universally accepted definition for ECC,[12,14,28] but the AAPD considers ECC as the presence of any decayed deciduous tooth surface (cavitated or non-cavitated), missing (due to caries) or filled, in children younger than six years. Based on this definition, the expression severe ECC (S-ECC) was adopted in lieu of rampant caries, in the presence of at least one of the following criteria: a) any sign of caries on a smooth surface in children younger than three years; b) any smooth surface of an anteroposterior deciduous tooth that is decayed, missing (due to caries) or filled, in children between three and five years old; c) decayed, missing, and filled teeth index (DMFT) equal to or greater than 4 at the age of 3, 5 at the age of 4 and 6 at the age of 5 years.[29] Unlike this definition, the WHO does not consider the presence of non-cavitated lesions for the DMFT.[22]

Etiology

Caries is regarded as an infectious, contagious and multifactorial disease produced by three primary individual factors: cariogenic microorganisms, cariogenic substrate and susceptible host (or tooth).[29] These factors interact in a certain period of time, causing an imbalance in the demineralization and remineralization between tooth surface and the adjacent plaque (biofilm).[5,30]

Cariogenic microorganisms

The main cariogenic microorganisms are the so-called mutans streptococci, especially *Streptococcus mutans* and *Streptococcus sobrinus.*[7,10,30] These pathogens can colonize the tooth surface and produce acids at a faster speed than the capacity of neutralization of the biofilm in an environment below the critical pH value (less than 5.5), which results in the destruction of the tooth enamel.[9,10,19] The major reservoir of mutans streptococci is the oral cavity, and infant infection depends on the level of maternal infection or on the person in closer contact with him or her.[7,10,29-31] Horizontal transmission also has been described in nursery facilities of day-care centers and within families.[31,32] The severity of ECC is directly related to the early establishment of *mutans streptococci* in the infant.[10,30]

These bacteria admittedly need nondesquamative surfaces to colonize because their positivity increases with the number of erupted teeth and with age.[30] In the period known as "window of infectivity", which corresponds to the eruption of lower incisors (6 months) and upper molars (24 months), the acquisition of streptococci increases.[7,9,10]

Other microorganisms include lactobacilli, which were associated with the progression of an established lesion and not with the development of caries itself.[8,30]

Cariogenic diet

Sucrose is the most important cariogenic food and the one most widely used by people. It turns non-cariogenic and anticariogenic foods into cariogenic ones.[6,7,19] Other sugars involved in cariogenesis are glucose and fructose, found in honey and fruit.[6,9,31] A simple exposure to cariogenic foods would not be a risk factor for dental caries, but the frequent and prolonged contact of these substances with teeth would.[6]

Susceptible host

Host risk factors for the development of caries are: yet immature post-eruptive enamel; presence of enamel defects, characterized mainly by hypoplasia;[5,9,11,19,30] morphology and genetic characteristics of the tooth (size, surface, depth of fossae and fissures) and crowded teeth.[9]

Saliva is the major defense system of the host against caries, removing foods and bacteria, and providing buffering against the acids produced. It functions as a mineral reservoir for calcium and phosphate, necessary for enamel remineralization, containing antibacterial substances.[9,10,19,30] Individual situations that decrease

salivary flow and, consequently, its buffering capacity, as occurs while infants are sleeping, increase tooth susceptibility to caries.[19,30,31]

The constant maintenance of fluorine in the oral cavity is important for enamel resistance, interfering with the dynamics of caries development, reducing the amount of minerals lost during demineralization and activating the response during remineralization.[6,11] In fact, fluorine does not prevent caries development, but it is extremely efficient in minimizing its progression, and control of dental plaque and diet is also important in order to maximize the effect of fluorine. Daily toothbrushing with fluoridated toothpaste and toothbrushing before going to bed are important measures for the control of caries, since they maintain the concentration of fluorine in the saliva for a longer period.[6]

Thus, caries starts with primary streptococcal infection, followed by the accumulation of streptococci in the biofilm at pathogenic concentrations secondary to the frequent and prolonged exposure to a cariogenic diet. Finally, fermentation of sugars by streptococci inside the dental plaque causes enamel demineralization, resulting in cavitation of dental structures.[9,11,29-31]

Caries develops from decalcification of upper deciduous incisors immediately after their eruption, affecting the deciduous molars and canines, if not controlled.[10,11] While the four upper deciduous incisors are the most severely affected by ECC, lower incisors remain intact because they are protected by the tongue and moistened by the saliva from submandibular glands,[10,11] as shown in Figure 1.

Figure 1 - Typical pattern of carie in infants and preschool children severely affecting upper teeth and lower molars, while lower incisors remain intact. Presence of abscesse in the upper right deciduous incisor. (Picture: Brian Palmer, DDS).

Associated risk factors

ECC is more commonly found in children who live in poverty or in poor economic conditions,[7,11,24-26,33-37] who belong to ethnical and racial minorities,[12,38] born to single mothers,[39] of parents with low educational level, especially of illiterate mothers.[7,26,28,33,37,39,40] In this population, prenatal and perinatal malnutrition or undernourishment are the cause of enamel hypoplasia; oral hygiene is usually poor; exposure to fluorine is probably insufficient[12,39] and there is a greater preference for sugary foods.[36,41]

Several diseases are associated with ECC, among them, malnutrition,[9,24,34,35,42] asthma, recurrent infections, chronic diseases, in addition to medication use.[9,30,40]

Malnutrition may cause enamel hypoplasia, and just like iron deficiency anemia, it may lead to reduced salivary secretion and low buffering capacity.[7,11,24,35,42,43] Childhood malnutrition is still a major problem in Brazil, especially in the North and Northeast regions,[44] which may contribute to a larger number of decayed teeth in these regions. The mean DMFT (number of deciduous teeth that are decayed, extracted or indicated to be extracted and filled) at the age of five years in the North region is approximately 27% higher than the mean for the Southeast region.[15] It also has been observed that the diet of Brazilian infants is poor in iron, monotonous, with regular use of cookies, thickeners, snack foods and sugar,[44] which are highly cariogenic.

Low birthweight, including preterm births, predisposes to high levels of streptococcal colonization,[45] in addition to favoring the development of enamel hypoplasia and salivary disorders.[30,43] In these newborns, enamel defects are associated with gestational diseases, such as maternal infection, metabolic disorders (hypoxemia, nutritional disorders, hypocalcemia) and performance of medical procedures (laryngoscopy and endotracheal intubation).[46]

In infants, the presence of infections, metabolic disorders, chemical toxicity and inherited diseases also cause the development of enamel hypoplasia.[11,30,43]

The severity of ECC increases with the severity of bronchial asthma, having as major cause the use of beta 2 agonists, which reduce salivary secretion, in addition to the fact that powder inhalers and oral medications contain sugar in their formulation.[47] Other situations that reduce salivary flow and predispose to the appearance of caries are diabetes mellitus and the use of medications such as antihistamines, benzodiazepines, antiemetics, expectorants and antispasmodics.[9]

Nipples, pacifiers and bottles

Baby bottles predispose to ECC because their nipple blocks the access of saliva to the upper incisors, whereas lower incisors are close to the main salivary glands and are protected from liquid contents by the bottle nipple and the tongue.[11] The use of baby bottles during the night is associated with the reduction in salivary flow and in the capacity of salivary neutralization, which would cause food stagnation in the teeth and prolonged exposure to fermentable carbohydrates.[9,30] Additionally, it has been demonstrated that infants with ECC sleep less at night, wake up more frequently, and receive more bottle-feedings as a way to manage their sleep problems.[48]

Although the habit of dipping the pacifier in sugar is associated with early colonization by *Streptococcus mutans* in predentate infants,[49] a systematic review did not find any consistent correlation between the use of pacifiers and the development of ECC, regardless of the length of use of pacifiers and of the introduction of sweeteners or not.[50]

Cariogenic role of human milk, cow's milk and milk-based formulas in infant feeding

Animal studies have shown that cow's milk does not produce caries and that it has a cariostatic action instead.[34,38,51] However, its use is not recommended before the first year of life.[52,53] Nevertheless, milk-based formulas for infant feeding, even those without sucrose in their formulation, proved to be cariogenic.[54-56] Breastmilk, compared with cow's milk, has a low mineral content, higher concentration of lactose (7 *versus* 3%) and lower protein content (1.2 g/100 ml *versus* 3.3 g/100 ml), but these differences are probably insignificant in terms of cariogenicity.[30]

Birkhed et al. demonstrated that human milk and cow's milk can reduce dental plaque pH values, but to a lesser extent than sucrose, and that the fermentation of lactose and cow's milk is slower. On top of that, streptococci can only increase lactose fermentation after frequent contact with the milk. According to these authors, this may be one of the reasons for caries development in deciduous teeth produced by prolonged breastfeeding on demand. However, for the same authors, the cariogenic potential of milk under normal conditions does not have clinical relevance, except when salivary protective factors are reduced, as occurs during sleep and in the presence of xerostomia.[57]

Breastfeeding *versus* ECC: reasons and counterarguments

Gardner et al.[58], Kotlow[59] and Brams et al.[60] were the first authors to associate ECC with breastfeeding in a report of nine cases, pre-establishing the behavior of dentistry regarding breastfeeding – recommending the cessation of breastfeeding as soon as the infant was able to drink from a cup, around the twelfth month of life.[10,19] These publications are open to criticism as they deal with a small number of cases, in addition to the fact that two infants were bottle-fed and there was no mention of enamel defects, bacterial medium and dietary composition.[61] for the remaining seven infants.

Most authors argue that caries is associated with breastfeeding when the consumption pattern has certain characteristics such as ad libitum feeding, large number of breastfeedings a day, prolonged breastfeeding and, mainly, frequent breastfeedings during the night, resulting in accumulation of milk in the teeth, which, combined with reduced salivary flow and lack of oral hygiene, may produce tooth decay.[10,16,18,19] In opposition to these arguments is the fact that breastmilk expressed directly into the soft palate[62] does not stagnate while being sucked[63] and the volume ingested by the infant is difficult to be quantified, in addition to the fact that there is no information in the literature on what an atypical consumption pattern is for nursing infants in relation to feeding frequency.[44,52] Another argument that is commonly found in the literature is that the addition of sucrose to human milk makes it cariogenic.[7,61] This statement is arguable because, in practice, this situation would hardly happen, since such addition should occur during the breastfeeding session by offering the infant something sweet to eat or drink during or immediately after breastfeeding.[63]

The various studies that investigated the association between breastfeeding and ECC are shown in Table 1. The most important limitation of these articles is that they do not employ the internationally adopted definitions of breastfeeding. Some authors do not present a definition for ECC,[40,64] while others use multiple definitions[12] or their own definitions.[65] As may be observed, most authors did not find a correlation between ECC and breastfeeding or with its duration.[12,25-27,40,65-70] The obtained results often are contradictory and the findings were not always reproduced. The same was observed by Valaitis et al. in a systematic review of 151 articles. These authors found a moderate correlation between breastfeeding and ECC in only three studies. They verified that the quality of the studies is relatively poor and that the variables were difficult to compare because their essential definitions were weak, inconsistent, ambiguous or even absent, for instance, the definition of breastfeeding on demand, exclusive breastfeeding and breastfeeding at night. Finally, these authors concluded that: (1) there is no strong and consistent evidence between breastfeeding and the development of ECC; (2) there is no specific period for weaning, and women should be encouraged to continue breastfeeding for as long as they wish; and (3) rigorous studies are necessary before issuing any public statements correlating breastfeeding with the development of ECC.[21]

In another systematic review involving 73 studies, Harris et al. identified 106 risk factors significantly associated with the prevalence or incidence of ECC. Among these, only three factors are related to breastfeeding (duration, frequency and breastfeeding at night) and three to breastfeeding and/or bottle-feeding (when used to feed or to stop the infant from crying at night, to put him/her to sleep and duration of breastfeeding longer than 18 months). Few articles showed a high methodological quality and used validation measures for oral hygiene and eating habits. Most of these studies showed that variables should be treated as risk indicators, as they are only probable or putative risk factors and were not able to clearly establish a relation between exposure and caries. The most consistent associations with caries were early streptococcal infection acquisition, highly cariogenic diet, poor toothbrushing routines and enamel hypoplasia.[5]

The following arguments refute the association between breastfeeding and ECC:

– There is substantial evidence that correlates eating habits with dental caries, and a common agreement that an increase in the incidence of caries may result from the

Table 1 - Studies that investigated the association between breastfeeding and early childhood caries

Authors/ country	Type of study Age group Sample size	Results	Significant risk factors associated with ECC, except for human milk	Notes
Matee et al.,[71] Tanzania	Cross-sectional, pediatric outpatient clinic AG: 1-2.5 years n = 442 (47 with ECC)	Association between S-ECC and prolonged breastfeeding on demand.	Linear enamel hypoplasia	Breastfeeding prevalence was not demonstrated. Complementary food was introduced between 1 and 9 months. Mothers whose children did not have S-ECC were not interviewed
Matee et al.,[66] Tanzania	Case-control, pediatric outpatient clinic. AG: 1-4 years 116 with ECC, 243 without ECC	Association of ECC with nocturnal breastfeeding; there was no association of ECC with breastfeeding duration	Linear enamel hypoplasia	There is not reference regarding the composition of the other components of the diet, the pre- and perinatal situation and the nutritional status; lack of dental hygiene was not taken into consideration. Other studies show that exclusive breastfeeding is common and that the early introduction of food is the rule in this population, and sorghum or corn porridge is almost the only complementary food[76,77]
Wendt et al.,[64] Sweden	Longitudinal, community of Jönkönping. AG: 1 year, seen at 2 and 3 years. n = 629 without caries; 593 seen at 3 years (159 with ECC)	ECC associated with breastfeeding for children aged < 2 months and > 1 year	Nocturnal snacks; bottle-feeding	Definition of carie is not presented. The study refers to other studies published by these authors. Only 7% were being breastfed at 1 year. Other authors suggest that breastfeeding does not cause caries, but could be associated with the child's diet and the educational practice of the family
Matee et al.,[72] Tanzania	Case-control, pediatric outpatient clinic. AG: 1-2.5 years 17 with S-ECC, 17 without ECC	Breastfeeding allows the colonization of *Streptococcus mutans*	Counting of *Streptococcus mutans* colonies	The same as for Matee et al., 1994
Wendt et al.,[40] Sweden	Cohort, community of Jönkönping. AG: 3 years n = 289 (83 with ECC)	There was no association between breastfeeding and ECC	Immigrants; use of bottle with sweetened liquids; poor oral hygiene; visible plaque; sweets intake > once a week	There is no definition of carie. The study refers to other studies published by these authors. Only 14 children were being breastfed at 1 year
Li et al.,[35] China	Cross-sectional, kindergartens of two rural communities. AG: 3-5 years n = 1,344 (1,106 with caries)	Progressive increase of the significance of the association between ECC and breastfeeding related to the duration of breastfeeding	Low income population; malnutrition; hypoplasia	No reference to the type of complementary diet and to the prevalence of breatfeeding
al Ghanim et al.,[73] Saudi Arabia	Case-control, three public outpatient clinics and three schools. AG: 3-5 years 231 without ECC, 215 with DMFT $\geq$ 8	Significant association of ECC with breastfeeding duration > 1 year, not confirmed in the logistic regression analysis	Predictive model: visible plaque; first dentist visit at 2 years; use of bottle with sweetened milk; frequency of the sweets intake	

DMFT = decayed, missing, and filled teeth index; ECC = early childhood caries; S-ECC = severe early childhood caries; AG = age group; n = total number of the sample.

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Weerheijm et al.,[25] Neatherland	Cross-sectional, La Leche Ligue in 25 towns. AG: 14-42 months n = 96 (14 with ECC)	There was no association between ECC and prolonged breastfeeding (mean 22 months)	Low use of fluorine	Presented different definitions for breastfeeding carie and carie
Mattos-Graner et al.,[74] Piracicaba, Brazil	Cross-sectional, random selection in public day care centers. AG: 12-30 months n = 142 (27 with ECC)	Higher prevalence of ECC in children who were never breastfed or who were breastfed up to 3 months if compared to those breastfed for longer than 12 months	Colonization of *Streptococcus mutans;* presence of bacterian plaque; use of sugar or cereal in the bottle; early introduction of salty meals	
Oulis et al.,[75] Greece	Cohort, pediatric dental clinic, Dental School, Athenas University. AG: 3-5 years 130 with ECC, 130 without ECC	Breastfeeding for longer than 40 days inhibits the occurence of ECC	Use of bottle to fall asleep	85% of the group without ECC and 95% of the group with ECC used bottle
Ramos-Gomez et al.,[12] United States	Cross-sectional, community of Stockton. AG: < 6 years, n = 220	There was no association between breastfeeding and ECC	Hygiene; frequency of food intake	Five definitions for ECC. Due to this, prevalence of ECC varied between 12.3 and 30.5%
Dini et al.,[33] Araraquara, Brazil	Cross-sectional, 25 public schools. AG: 3-4 years n = 245 (112 with ECC)	Higher risk for children who were never breastfed or who were being breastfed for longer than 24 months	Low income population	Exclusive breastfeeding definition is not clear: children at 3 and 4 years being exclusively breastfed
Hallet et al.,[38] Australia	Cross-sectional, community. AG: 4-6 years n = 3,375 (1,269 with ECC)	Significant association of ECC in children who were never breastfed or in those who were being breastfed for longer than 2 years if compared to those breastfed for less than 24 months	Use of bottle, mainly after 12 months, in bed, at night, frequently drinking sweetened liquids throughout the day; beginning to use cups after 24 months; introduction of solid foods after 9 months; race (non-Caucasians); single mothers	
Rosemblatt et al.,[67] Recife, Brazil	Cross-sectional, Outpatient Clinic Amauri de Medeiros. AG: 12-36 months n = 468 (133 with ECC)	There was no association between breastfeeding and ECC	Cariogenic diet; number of snacks	Most children had been breastfed up to the sixth month of life, the exact number of children was not determined
Rajab et al.,[26] Jordan	Cross-sectional, 27 day care centers and schools. AG: 1-5 years n = 384 (184 with ECC)	There was no association between ECC and the duration of breastfeeding	Use of bottle with sweetened liquids after 1 year old; going to bed with the bottle; frequency of the intake of sweet snacks (more often than three times a day); no toothbrushing; no dentist visits; low income	

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Authors/ country	Type of study Age group Sample size	Results	Significant risk factors associated with ECC, except for human milk	Notes
Huntington et al.,[28] United States	Case-control in Latin families, Department of Pediatric Dentistry, Boston University. AG: with ECC, up to 5 years; with no caries, with age restrictions n = 100 with ECC, 60 with ECC	Breastfeeding presented lower significant risk of ECC; children who were not breastfed had twice the risk of ECC if compared to their siblings who were breastfed	Food intake while sleeping, frequency of toothbrushing up to once a day, toothbrushing without parent supervision, last parents' dentist visit more than 2 years ago, parents' educational level	
Santos et al.,[65] Rio de Janeiro, Brazil	Cross-sectional, Pediatric Outpatient Clinic of HUPE-UERJ. AG: 0-36 months n = 80 (32 with ECC)	There was no association between breastfeeding and ECC	Visible plaque	
Cariño et al.,[27] Philippines	Cross-sectional, community. AG: 2-6 years n = 993 (586 with ECC)	There was no association between breastfeeding and ECC	Toothbrushing was introduced after 1 year old; daily frequency of snacks	Breastfeeding was a rule, but the prevalence was not determined
King et al.,[68] China	Cross-sectional, 33 day care centers. AG: 0-4 years n = 353 (65 with ECC)	There was no association between breastfeeding and ECC		Only 4% of the sample was being breastfed after 6 months of age
Jose et al.,[69] India	Cross-sectional, 13 day care centers. AG: 8-48 months n = 513 (216 with ECC)	There was no association between breastfeeding and ECC	Lack of oral hygiene; low income; mothers with caries; frequent snacks	99% of the children were being breastfed on demand. Even though there was no definition of breastfeeding, 5% of the sample was being exclusively breastfed
Vachirarojpisan et al.,[37] Thailand	Cross-sectional, District of U-thong. AG: 6-19 months n = 387 (226 with ECC)	Significant association between ECC and breastfeeding. It was not confirmed by the multivariate logistic regression analysis	Low income; low maternal educational level; high levels of *Streptococcus mutans* in the oral cavity; nocturnal food intake with bottle	Breastfeeding was the rule, but the prevalence was not determined
Dye et al.,[70] United States	Cross-sectional, data of the health and nutrition census. AG: 2-5 years n = 4,236 (1,265 with ECC)	There was no association between breastfeeding and ECC	Race (Latin, Non-caucasian); low parental school level; low income; low intake of fruits and vegetables, frequent snacks	

DMFT = decayed, missing, and filled teeth index; ECC = early childhood caries; S-ECC = severe early childhood caries; AG = age group; n = total number of the sample.

civilization of man, producing changes in the most natural lifestyles.[9,18] Studies involving primitive cultures, in which the rule was to breastfeed on demand, including breastfeeding at night, up to 18-36 months, show an extremely low prevalence of caries among children.[61,78] Classical studies show caries rates of 0.5% in Samoan infants[79] and of 1.2% in Eskimo infants.[80] Similar results were obtained from anthropological studies, in which preneolithic (12,000 a. C.) human skulls did not reveal dental caries and neolithic (12,000 to 3,000 a. C.) skulls with decayed teeth belonged predominantly to old people.[78] The analysis of 1,344 prehistorical human deciduous teeth of native Americans from South Dakota, USA, revealed that only 19 (1.4%) were decayed and only three had extensive caries lesions.[63] In modern times, the prevalence ob-

served in 16 native American communities, with the same culture, was 54%.[81]

- Peoples that maintain ancestral eating habits have a low prevalence of caries; however, when they come into contact with modern civilization and its eating habits, the prevalence rate increases drastically.[8]
- Children's eating habits have dramatically changed in the last years. Milk consumption has decreased whereas the consumption of soft drinks, juices, non-citric beverages and carbohydrates has increased.[70,82] These habits have been correlated with a higher prevalence of ECC.[82]
- The duration of breastfeeding and exclusive breastfeeding is longer in women from upper social classes, in those who are better educated,[83-85] in older mothers and in those with a steady relationship[52] and, dental hygiene is also more appropriate in this group[12,39] in opposition to underprivileged classes, in which ECC is more common. Early introduction of foods, the use of baby bottles and preference for sugary foods are more frequently observed in underprivileged classes.[36,41,44,52,86,87]
- The prevalence of breastfeeding decreases with age, having very low rates in children aged between 12 and 24 months in Brazil[44] and in the world,[88] in contrast with the prevalence of ECC.[12,27,65,67]
- The prevalence of ECC has been constant over the years[6,67,73] even with an increase in the world prevalence of breastfeeding[89] and a fourfold increase in its median in the last three decades in Brazil.[90]
- Preterm and low birthweight infants, who are at great risk for ECC, tend to have a shorter breastfeeding period,[46,91,92] be bottle-fed for longer periods and ingest more sugar.[46]
- Studies have demonstrated that breastmilk reduces the risk of diseases, such as gastroenteritis, infections,[93] asthma, atopic diseases[94] and diabetes mellitus,[95,96] which have some influence on infant feeding. Therefore, breastmilk supposedly protects against caries, due to the reduced development of disorders that contribute to the pathophysiology of caries and due to the reduced use of cariogenic medications.
- Human milk is characterized by a complex defense system that inhibits the growth of several microorganisms, including mutans streptococci.[97,98] The IgA antibodies found in the milk can interfere with the colonization of pioneer streptococci and consequently with the colonization of other bacteria that inhabit the oral cavity. Nutrient content, buffering capacity and other defense mechanisms found in breastmilk may interfere with the existing microbiota.[99]
- Breastmilk contains a mix of oligosaccharides that is complex and exclusive to the human species, found in tiny amounts in very few mammals, which may act at the initial infectious stage by inhibiting bacterial adhesion to epithelial surfaces.[99] Therefore, studies that used lactose or milk from other animal species may not have their results extrapolated to breastmilk due to its distinct composition.
- Qualitatively, it has been demonstrated that human milk is not cariogenic, as the dental plaque it forms is different from that formed by sucrose. In addition, human milk does not cause clinically visible mineral loss in the enamel, contrary to what occurs with sucrose.[100]
- Experimentally, it has been shown that human milk is not cariogenic because it does not decrease the enamel pH significantly in breastfed infants, aged between 12 and 24 months; allows moderate growth of *Streptococcus sobrinus* (i.e., it does not inhibit or stimulate the growth of this microorganism)*;* promotes enamel remineralization by way of calcium and phosphate deposition on the enamel surface; has a poor buffering capacity; and does not cause *in vitro* enamel decalcification after twelve weeks. However, when sucrose is added to human milk, caries developed in the dentin within 3.2 weeks.[61]

In summary, studies that correlated ECC with breastfeeding invariably observed the factors related to caries development, putting aside those factors related to breastfeeding. Many of these factors serve as confounding variables as they interfere in breastfeeding and in caries development as well (Figure 2). Figure 2 shows all the situations that were previously discussed in the present paper, where solid arrows stand for a stimulatory effect and dotted arrows represent an inhibitory effect for each situation proposed.

Official view of the American Academy of Pediatric Dentistry (AAPD)

Currently, the AAPD supports the recommendations made by the American Academy of Pediatrics regarding breastfeeding (of at least one year). However, it states that frequent feeding at night including bottle-feeding, breastfeeding on demand and frequent use of spill-proof drinking cups is associated with ECC, but is not consistently implicated. It recommends that infants should not be put to bed with the baby bottle and that ad libitum breastfeeding at night should be avoided after the eruption of the first tooth. Therefore, future research should be conducted about the effects of breastfeeding and human milk consumption on oral health and on dentofacial growth. This view is ambiguous and arguable because the AAPD no longer includes breastfeeding among cariogenic factors.[29] Moreover, no scientific evidence exists that human milk is cariogenic,[61] even if ingested ad libitum and during the night.[63] Concomitantly, the view of the AAPD can also result in practical problems regarding the counseling and guidance of parents of those infants who wake up crying at night in order to be breastfed, simply expressing a need that should be met for infants' proper development. Finally, given the irreversible nature of caries, an actual test involving humans could be regarded as unethical.[56]

Final remarks

Although there is no scientific evidence that confirms the association between breastfeeding and caries, many professionals still express disbelief at the fact that human

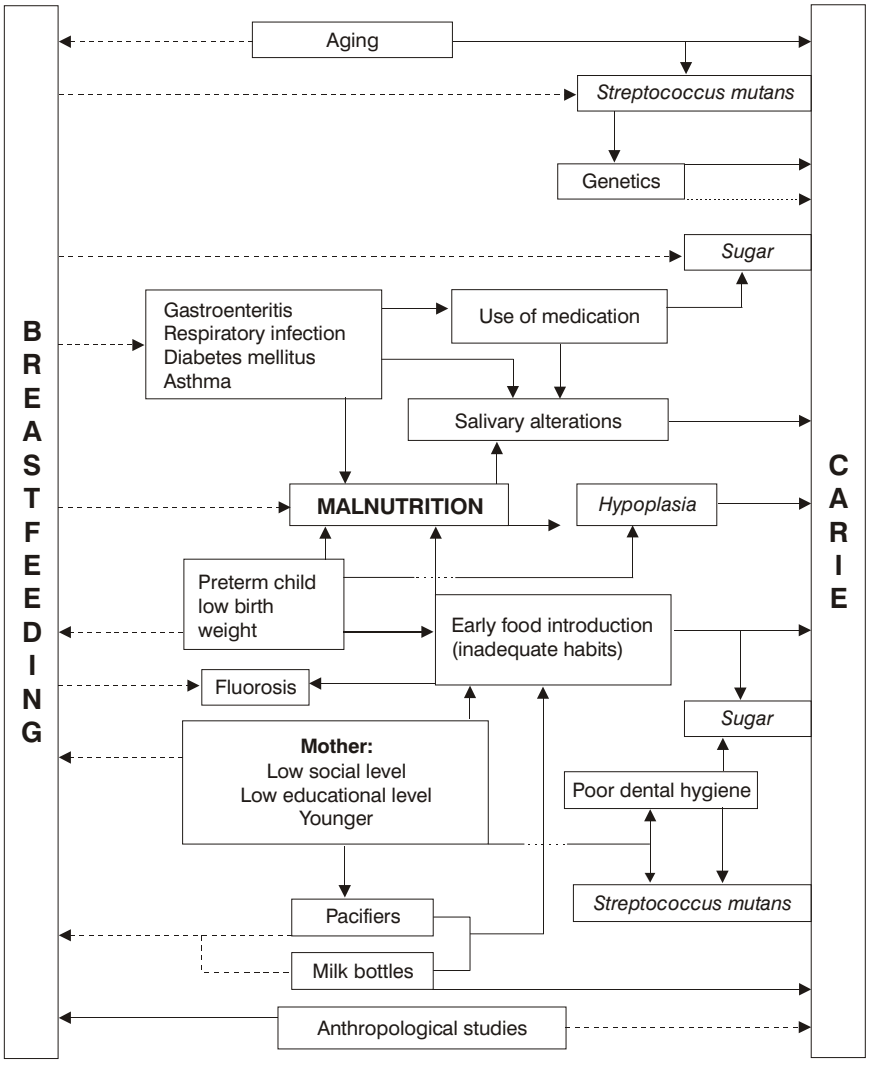

Figure 2 - Breastfeeding and early childhood caries interrelated factors

milk is non-cariogenic, thus cultivating the myth into which this association turned. We believe that breastfeeding at night should not be discouraged and no strict diet should be adopted for a nursing infant. At this age, infants are still adapting to complementary foods, adjusting themselves to new eating patterns and learning to regulate their schedules. Therefore, exclusive breastfeeding should be encouraged up to the sixth month of life, maintained at least up to the second year of life, with flexibility of schedules or shifts, and complemented with appropriate weaning foods.

This review led us to conclude that there is no scientific evidence that confirms that breastmilk is associated with caries development. This relationship is complex and contains several confounding variables, mainly infection caused by mutans streptococci, enamel hypoplasia, intake of sugars in varied forms and social conditions represented by parental educational and socioeconomic level.

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